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ABSTRACT

Public Gains, Private Strains: Public Investment and Private Schooling in Peru*

In the 2010s, Peru experienced an increase in public educational investment, a substantial improvement in public school learning outcomes, and an erosion in the private sector learning premium. We use longitudinal, geo-coded register data on primary schools and pupils in urban areas to study how the improvement in public schooling affected private schools. With a difference in differences (DiD) framework, we demonstrate that the increase in public school quality reduced enrolment and test scores in private schools, primarily in areas with lower education levels. A staggered DiD analysis shows that new public school openings also reduced enrolment in nearby private schools.

JEL Classification: H52, I20, L33, N36

Keywords: education policy, school quality, school competition, Latin America

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1 Introduction

The delivery of private education has expanded significantly in low and middle-income countries over the past decades, especially in urban areas. The quality of private schools is often highly variable, ranging from smaller, lower quality, low fee schools to larger, high fee, elite schools (see e.g UNESCO, 2021, for developments). For some, a private school is an automatic choice, regardless of public school quality, while others have resorted to a private school due to an underperforming or neglected public sector. Several countries, both developed and developing, have also introduced voucher type systems, where the government funds enrolment in private schools; a trend that contributes to a further expansion of the private sector (see e.g. Epple et al, 2017 for a review). Private school expansion increases choice and can, at best, put pressure on public schools to improve. However, it can also increase inequality in educational provision, and its expansion becomes particularly concerning when many private schools underperform public sector schools.

There is a sizeable literature analyzing the competitive impact of private sector expansion on the public sector (see e.g. Urquiola, 2016 for a review), and a long-standing debate on the effectiveness of school funding and resources in the public sector (see e.g. Jackson and Mackevicius, 2024, Glewwe and Muralidharan, 2016). In contrast, there are only a limited number of studies on the impact of public sector expansion or investment on the private sector. We contribute to the latter literature by focusing on Peru between 2007-2019, a period that saw a significant increase in the public sector education budget, and a substantial improvement in public sector learning outcomes. Like many other developing and emerging economies, Peru has seen a proliferation of private schooling over the past few decades, with highly variable quality. More specifically, we analyze whether the improvement in public sector quality changed the relative attractiveness of the private sector, with implications for enrolment and test scores.

For our analysis, we rely on a geo-coded, longitudinal administrative data set of primary schools in urban areas and annual test scores for second grade pupils in these schools. The data show that funding, resourcing and results for public schools improved rapidly over 2011-16, and towards the end, public sector test results exceeded those of most private schools. The

increase in public sector learning outcomes was not accompanied by a similar increase in private sector learning, implying a significant erosion of the private sector learning premium.

Our hypothesis is that as public school quality improved, parents who were on the margins of choosing between private and public schools, would increasingly choose a public one. To the extent that there is capacity, this should manifest itself as a fall in private school enrolment, in particular for academically weaker schools. We are primarily interested in the impact of a quality change in the public sector on the private sector, but also conduct an analysis on quantity change, by studying how the opening of a public school in the immediate vicinity affects private schools. With our evaluation, we aim to provide an answer to the broader question of whether it is possible to reverse the pull of the private sector by investing in the public sector.

There are a limited number of related previous studies that focus on either the impact of public school quantity or quality expansion on private schools. Regarding quantity, Chakrabarti and Roy (2016) examine whether the expansion of charter schools in Michigan, US, affected private school enrolment, and find no effect. Dinerstein et al. (2023) study a sizeable expansion of public schools in the Dominican Republic, and find large effects on the private sector; private schools were more likely to close, reduce prices, and improve quality in response to the public sector expansion.

Regarding the quality of public sector schooling, Dinerstein and Smith (2021) study the response of the private sector on a school funding reform in New York City that aimed to improve the quality of public schooling. Their research shows that the private sector adjusts to public school improvement; a significant boost in local public school funding led to a reduction in private sector supply within 1 mile of these public schools. Estevan's (2015) results for Brazil echo these findings; a public sector funding reform reduced private school enrolment in grade 1, but less so at higher grades, as there is a cost to switching schools. Using a randomized controlled trial, Andrabi et al (2024) study the equilibrium learning effects of a public school grants program in Pakistani villages. The program not only improved learning in the public sector, but also had a positive, competitive impact on private sector test scores, with a larger impact on those schools that faced a competitive threat.

In terms of modelling the effects of the public sector quality improvement on private schools, we rely on a difference in differences framework similar to Dinerstein and Smith (2021). We treat the drive to improve the public sector as an 'event' which in our main specification is timed to begin in 2012, when a new government was in power and the education budget started to expand significantly. We also conduct robustness checks, where the event starts instead in 2014, to coincide with the timing of a large-scale teacher career reform. Our control schools are those private schools that are shielded from public sector competition; more specifically those with no public sector competitors within a 1 kilometer radius. It is worth noting here that the choice of primary school is likely to be very local; our data suggest that in urban areas there is an abundance of schools within a small radius. We study the effects of the public sector quality improvement on private primary school enrolment and test scores of second grade pupils in urban areas.

The results indicate that the improvement in public school quality had a negative impact on private sector enrolment, an average decrease of 10 percent four years after the funding increases accelerated, and a 17 percent fall after seven years. The effect is concentrated on areas with lower parental schooling, suggesting that families with weaker socio-economic status acted on the improvement of public schools, which is expected. These findings are also supported by a separate pupil level panel data analysis. On learning, the results suggest that the increased competitive pressure from the public sector also led to weaker test performance for private school pupils. This data set does not allow us to determine precisely whether this is explained by pupil selection or changes within schools. However, additional analysis with a separate pupil panel data set suggests that pupil selection is unlikely to explain the reduction of academic results in private schools**.**

While in urban areas, the investment focused more on quality than an increase in the physical number of schools, as an additional analysis, we also study the impact at the extensive margin. In this case, we compare enrolment and learning in a set of private schools before and after the opening of a new public school, depending on how close they were to the new public school. We estimate a staggered difference in differences model for school openings that take place throughout the period studied, relying on the estimator by Callaway and Sant'Anna (2021). We find that those private schools that were within 1 kilometers of the new school opening, lost pupils compared to the control group: private schools which were within 1-2 kilometers of the new school. We also find substantial heterogeneity in this effect. The negative impact on

private school enrolment was larger in the latter part of the period, when public schools were performing better, and the negative effects were concentrated in areas of lower socio-economic status, and to private schools which were academically weaker.

Overall, our results demonstrate that significant investment in public schooling has the potential to crowd out private schools and rapidly improve educational attainment. A simple analysis of costs versus expenditure suggests that by the end of the period studied, public schooling was transformed into a cost-effective provider of education in relation to the private sector. Whether the public sector improvements in Peru were sustainable in the longer run would require a longer series of data, which is complicated by the COVID-19 pandemic from 2020 onwards, which led to school closures.

The paper is structured as follows. Section 2 describes private schooling in Peru and background to the educational investments and reforms. Section 3 describes the data and illustrates a number of stylized facts. Section 4 presents the difference in differences analysis on the effects of public sector quality improvement on the private sector. Section 5 reports the results on the opening of new public schools. Section 6 provides additional support for our findings using value-added estimations for public and private sector pupils with a separate pupil panel data set. Section 7 provides a conclusion and a discussion.

2 Background: Private Education and Educational Reforms in Peru

2.1 Private education in Peru

The share of children attending a private primary school in Peru has risen over the past decades and over the period studied was around 40 percent in urban Peru. This trend is similar to Latin America more generally (see Elecqua et al., 2018). This is partly because public education systems were seen as failing, often due to weak academic results, teacher strikes and high costs for the taxpayer (Balarin, 2015, Cuenca, 2016). The private sector has been largely unregulated and very heterogeneous in terms of fees and quality of instruction. While vouchers or public subsidies for private schools have been a feature in some Latin American countries, this is not the case for Peru. Whereas there is a small chain of catholic private schools which is publicly subsidized (Fe y Alegría), these schools comprise no more than two percent of pupils.

However, there has been a debate on the introduction of public-private partnerships in the form of 'school vouchers', which would allow parents to purchase private schooling (see e.g. Alonso-Pastor and Osain, 2023 for a review).

As recognized by Elecqua et al (2018), among others, the lack of state capacity has been one of the key drivers of private sector growth in Latin America. This relates to both the quantity and quality of educational provision. In growing urban areas, lack of school places or longer distances create demand for private education. Similarly, as consumers' earnings grow, their demand for the quality of education increases, often precisely in urban areas. Both of these factors lead to the growth of private schooling, particularly in capital cities and other urban conglomerates.

2.2. Educational reforms

The public education budget started to grow significantly more rapidly after 2011 and expanded by 75 percent between 2011-2016 in nominal terms (Figure 1). The regional budget accounts for the largest share of the total education budget. Out of the 25 regions in Peru ('Departamentos'), 24 fund their basic education via the regional budget. The exception is the capital region of Lima, which funds its basic education via the national budget. The national budget is also more important for higher levels of education, such as universities.

A number of reforms were implemented over the decade studied, during the two governments of Ollanta Humala (2011-2016) and Pedro Pablo Kuczynski (2016-18). The Education minister Jaime Saavedra (2013-2016) also played a substantial role. The impetus for the reforms was provided partly by the weak performance of Peruvian students in the 2009 and 2012 International PISA assessments. In 2012, Peru scored the worst among all participating countries, which led to a national outrage in December 2013 (Saavedra, 2023, pp. 70-73). Saavedra and Gutierrez (2020) divide the 2011-15 reforms into the following categories: 1) upgrades to infrastructure, 2) teacher-related reforms, 3) curricular and pedagogical reforms, 4) management of school systems. A broader context to the political economy of these reforms is provided by Balarin (2021) and Balarin and Saavedra (2023).

The ‘Program of Maintenance of Educational Infrastructure’ has since 2012 directed financing for schools for basic repairs and maintenance of school infrastructure. A national program to close the infrastructure gaps, the ‘National Educational Infrastructure Program’ (PRONIED) also started in 2014. A key teacher-related reform was the enactment of the 2012 law *Ley de Reforma Magisterial*, which followed the 2007 *Ley de Carrera Publica Magisterial*. This reform introduced a change to the process of hiring and promoting teachers, based on performance evaluations. The first teacher promotion contests took place in 2014. Individual schools were also rewarded for good performance, based on the *Bono Escuela* program from 2014-15. A non-trivial salary bonus was given to principals and teachers for the top third of schools in a region, based on a performance formula that accounted for learning outcomes, enrolment and pupil retention. Bono Escuela has been evaluated for instance by Leon (2016), who concludes that the program had a positive effect on Mathematics test scores, and that it improved the attendance of teachers and school directors.

In 2014, another intervention, the *Acompanamiento Pedagogico Multigrado* involved visits providing teachers feedback and continuous coaching on pedagogical practices in single-teacher and multigrade primary schools - typically small schools in remote areas. Castro et al. (2025) evaluate a 2016 randomised reassignment of the program and find that the teachers trained by this program improved their pupils’ test scores by over 0.2 standard deviations.

In terms of school management, the role of school principals was strengthened from 2015 onwards, when about a third of existing principal positions were assigned on a meritocratic basis. Principals were also given more autonomy, for example with regards to minor maintenance purchases. Further to this, from 2015 onwards, the collection of data from schools and the use of data were improved under a tool, *Semaforo Escuela*, which recorded information on school functioning and attendance based on school visits and teacher interviews.

Some reforms focused mainly on secondary schools. For example, *Jornada Escolar Completa* (JEC), introduced in 2015, extended the length of the school day in secondary schools. Agüero et al. (2021) found that learning outcomes, especially in Mathematics, improved as a result.

In our analysis, we treat the reforms as a package, instead of attempting to isolate the role of a specific reform or policy. This is warranted given that we are studying the implications of the overall improvement in public sector quality, which is very likely to be attributable to a number

of reforms. The multiplicative effect of several reforms will have changed the overall observed quality of the public sector, as well as public perceptions of public schooling. This approach is in contrast to several studies that have attempted to evaluate the impact of an individual reform on the public sector schools or pupils, as mentioned above. The bundling of a number of reforms does pose a challenge to such studies; even with random or quasi-random implementation, there will be ongoing trends due to other reforms, which may or may not interfere with the particular evaluation of interest.

More precisely, we consider the reforms a package of public investment, which begins in 2011; a year that coincides with the election of a new government, and represents the starting point of the significant budget increases. We consider 2012 as the first year of "treatment" as this represents the first full year when the new government was in power. This year does precede several of the reforms, which were not implemented until the middle of the 2010s. Therefore, as a robustness check, we conduct an alternative estimation in which we assume that the year 2014 represents the first year of treatment. This coincides for instance with the year that the teacher career law of 2012 was first implemented. Given the importance of teachers for learning, this reform is likely to be one of the key reforms that influenced learning in public schools. Appendix Table A2 also shows that salaries and remuneration cover a large share of the regional education budget, and that the growth in teacher salaries was larger than the growth of the total budget in several years beginning from 2013.

3 Data and descriptive analysis

3.1 Data

Our school level data come from the Censo Escolar (2006-2019), which is an annual school census containing details on school infrastructure, location, teachers, and pupils, among other things. It covers all primary schools in Peru, both public and private.[1] We link these data to repeated cross-sectional pupil level test score data from the Evaluación Censal de Estudiantes (2007-2016). This includes nationally comparable, annual test score data for second grade pupils in Reading and Mathematics. The second grade test score data are available continuously

[1] The sampling excludes schools with fewer than 5 pupils.

for 2007-2016. We have chosen to focus on primary schooling, as the second grade is the only level for which there is a continuous series for a longer time period, covering a period pre and post the expansion of investment in public schooling. After 2016, the focus shifted to collecting test scores at higher grades. These data sets contain limited information on household or parental characteristics, over the time period studied.

For a subset of pupils, a longitudinal dataset that tracks pupils and their test scores in grades 2 and 8, is available for four cohorts. This can also be matched to the school census for the same period and includes a family specific measure of socio-economic status. We utilize these data in a pupil level analysis in Section 6. In addition, we use the population Censuses of 2007 and 2017 for a few different purposes. For public finance regarding education, we use the Portal de transparencia del Ministerio de Economía y Finanzas (MEF, 2005-2019).

The data pose a limitation to studying school exit, or closure as an outcome variable at a fine geographic level, given that the geolocation of schools is available only from 2016 onwards. We rely on the geographic location to establish the presence and extent of public sector competition for private schools, and thus our analysis can only include schools that existed in 2016. Appendix A provides an analysis on the determinants of exit rates of schools generally prior to 2016, and concludes that school exit rates prior to 2016 are both small and largely uncorrelated with observables. This suggests that the data limitation is unlikely to lead to a concerning level of selection.

One further limitation concerns data on private school fees, which are not readily available for the period we study. We use the data for fees in 2020 (Identicole, 2020) to generate a few descriptive statistics.[2] These relate to private schools in our sample that were operational in 2020. There is a strong correlation between learning levels in our data and the prices in 2020, despite the time difference. However, as the school price data can be imprecise, they don't play a fundamental role in our analysis and are only used to categorize schools into price quartiles in descriptive analysis (in Figure 4 and Table 1).

[2] Source, Identicole website: https://identicole.minedu.gob.pe

3.2 General descriptives

We begin the description of Peruvian primary education with a set of graphs (Figure 2). The left-hand figure shows total primary enrolment in 'urban' districts of Peru for both the public and private sector. Urban districts are defined as those 255 districts that were at least 80 percent urban in the 2007 census. The figure shows that the popularity of private schooling has increased steadily. While public sector enrolment declines at first, it experiences a turnaround soon after the start of the reform period, with growth rates eventually surpassing growth of private sector enrolment. The right-hand side of Figure 2 shows that the share of pupils attending private schools starts to decline from 2014 onwards. These developments highlight a sudden change in the appeal of the public school system, which is in contrast to the pattern in much of Latin America (Elecqua et al, 2018). It should be noted that some of the increase in enrolment in both sectors since 2012-13 can be attributed to larger birth cohorts entering school (see Appendix Table A3).

The next figure (Figure 3) documents how the learning premium associated with the private sector has been eroding over the period of 2007-2016. Reading scores in the public sector catch up nearly completely with private sector test scores by 2016, whereas the public sector exceeded the private sector in Mathematics performance already by 2014.

In Figure 4, the developments in combined Mathematics and Reading scores are shown separately for four price quartiles of private schools, together with the combined scores for the public sector. The figure illustrates that test scores in public schools surpass those in all the three lower price quartiles by 2014 and almost reach the level of the top quartile of private schools by 2016.

Figure 5 plots data on the following key school inputs by sector: the pupil-teacher ratio (PTR), basic infrastructure resources and the number of computers per pupil. PTRs in the public sector have been improving, but have remained much higher (at about 22 pupils per teacher) than in the private sector, where the same figure hovers around 15. 'Basic resources' refers to an index consisting of five items, for which we were able to obtain a consistent series of data for the entire period studied: water, sewage, electricity, toilet and internet. Each school is rated between 0-5, and the values averaged over the urban districts by year, weighted by pupil

numbers. Here too, the public sector has been catching up with the private sector, and there has been rapid improvement in infrastructure over time, as well as in the number of computers per pupil, partly explained by the increased emphasis on infrastructure investments.

Overall, the above descriptive evidence suggests that by 2014, the great majority of private schools were underperforming the public ones. We should emphasize that these figures do not control for pupil selection. Private school pupils typically have parents with more resources than average, suggesting that if we were able to control for parental socio-economic status, the relative performance of private schools would appear even lower.

The erosion of the private school learning premium should improve parental perception of public sector schools, if they are informed. Earlier research shows that there are various motives for choosing private schools, which extend beyond the academic quality of the school. For example, Balarin (2015) suggests that in the Peruvian context an important factor for many parents in urban areas is the proximity of small local private schools; proximity and smaller size of the private schools are perceived to be safer by parents.

4 Public school quality and private school enrolment

This Section focuses on the estimation and results on the impact of the improvement in public schools on private school enrolment and test scores. We begin by describing the conceptual framework. This is followed by a presentation of the econometric model and a discussion of the results and robustness checks.

4.1 Conceptual framework

Our hypothesis is that as public school quality improves, parents who are on the margin of choosing between private and public schools, will increasingly choose a public one. This should manifest itself as a loss of pupils for private schools, particularly among the private schools that hold no local market power, or in other words, are competing for the same ‘customers’ as the public sector.

For a simplified model of school competition, suppose that parents choose schools based on the perceived school quality (ϕ), and the costs (C) associated with sending children to the school. Quality is based on perceptions and reputation, as comparative school test results are generally not published in mainstream media. One can assume that increasing educational budgets shape perceptions, as does word of mouth, possibly with a lag. The costs may differ depending on whether the school is public or private, with tuition being the main component of the cost. If parents compare their most preferred public and private schools, they face a binary choice of the form

(1) $max\{School^{priv}, School^{pub}\} = \max\{f(\phi^{priv}, C^{priv}), f(\phi^{pub}, C^{pub})\}$

In this formulation, $\frac{\partial f(\phi,C)}{\partial \phi} > 0$ and $\frac{\partial f(\phi,c)}{\partial C} < 0$ and parents choose private over public whenever $f(\phi^{priv}, C^{priv}) > f(\phi^{pub}, C^{pub})$. Let's assume that the utility function is linear in quality and cost, and costs consist of tuition fees (π) and the distance to the school (d), both of which have been shown to be key factors for parents of primary school pupils in urban Peru (Balarin, 2015)[3]. Equation (2) provides a straightforward framework for assessing the effects of an improvement in public school quality.

(2) $(\phi^{priv} - \phi^{pub}) > [(d^{priv} - d^{pub}) + \pi]$.

For a parent to choose a private school, its quality premium has to exceed the costs due to tuition and excess distance (admitting that private school can be closer than public one). Improvements in public school quality would make marginal parents more likely to choose public schooling. Similarly, establishing new public schools would reduce d^{pub} for local parents, leading to shrinking of the private schools, if the quality of the public school is sufficiently high.

Let's denote n as the number of students enrolled in the school (school size). From the arguments above, it is apparent that n^{priv} is a function of its own π, d, ϕ and any other costs

[3] Balarin (2015) writes: "In most cases, the study found that the reasons for choosing a private school had to do with the closeness of the school to the home, which makes schooling more compatible with the families' (especially the mothers') other domestic responsibilities […] in precarious urban contexts that are perceived by their dwellers as being very high risk".

associated with schooling, but also that of its competitors. This highlights that competitive pressure directly affects enrolment. In this framework, enrolment is equal to the number of parent–child pairs *i* for whom the perceived net utility of the private school exceeds that of the public school. Formally, let $U_i^{priv} = \varphi_i^{priv} - \pi_i - d_i^{priv}$ and $U_i^{pub} = \varphi_i^{pub} - d_i^{pub}$. Then private enrolment is: $n^{priv} = \sum_{i=1}^{N} \mathbb{1}(U_i^{priv} > U_i^{pub})$, where $\mathbb{1}$ is the indicator function. This implies that upon a decrease in d_i^{pub} or a perceived improvement in ϕ_i^{pub}, the private school will lose pupils and shrink in size.

While we abstract from more detailed aspects of competition, it is necessary to point out that when facing new competitive pressure, private schools may react by raising quality or reducing the price. However, their ability to do so would depend on their existing cost structure and profit margins. Given the large numbers of private schools in Peruvian urban areas, there is good reason to believe these markets to be quite competitive and local. For the average urban private primary school in Peru in 2011, there were 19.6 other private and 6.8 public schools within a 1km radius (Figure 6). Figures 7a and 7b illustrate how densely public and private schools are located on a map for areas in and around Lima.

4.2 Econometric model

Our hypothesis is that the improvement in public school quality, as manifested by the general improvement of test scores after 2011, increases competitive pressure on private schools. To test this, we rely on a difference in differences framework similar to Dinerstein and Smith (2021). In our main specification, we treat the post-2011 period as an event, but also conduct robustness checks, where the event begins in 2014, as discussed above in Section 2.2. We leverage the geographic location of each school to determine treatment and control groups. The treatment group includes private schools that have a public school nearby (within a 1 km radius), and the control group consists of those private schools that don't and are thus less likely to be affected by the improvement in public sector learning. As explained in Section 4.1, and demonstrated by Figures 6 and 7a and 7b, there is often an abundance of schools in the near vicinity in urban areas, which justifies out choice of a 1km radius.

Our sample is confined to schools in "urban" districts. These are the 255 Peruvian districts, which were at least 80 percent urban in the 2007 Census. This allows us to focus on the most urban areas in Peru, while keeping the geographic domain of the analysis fixed over time.

With the full set of urban private schools, we first estimate the following school level model

$$(3)\ \text{Ln}(\text{Enrolment}_i) = \beta_1 \text{Post}_t \times \text{Treat}_i + \lambda_i + \theta_t + \varepsilon_{it}$$

The dependent variable is the log of private school (*i*) enrolment. The model includes school fixed effects (λ_i) and year dummies (θ_t). 'Treat' is defined as 1 if the private school has public sector competitor(s) within a 1km radius, and zero, if it doesn't. The control group thus has no immediate local public sector equivalent. The Post_t variable takes a value of 1 in years after 2011, and 0 before that.

The local 1-km radii of schools are highly overlapping, and this spatial correlation would lead to incorrect standard errors. This is addressed using an arbitrary correlation regression by Colella et al (2023), which adjusts the standard errors based on correlation of residuals within 1-km distance of the schools.

In the analysis, we also assess the general 'parallel trends' assumption required for difference in differences analysis; whether the trends in private school enrolment are similar in treatment and control schools prior to the reform. We also provide results for robustness checks where the radius is 0.5 and 1.5km instead of 1km, a placebo check using only pre-treatment periods, and a model where the first year of treatment is considered to be 2014.

In addition to models with enrolment as the dependent variable, we also estimate school level models where the dependent variable corresponds to the average second grade test scores for private schools. Private schools may respond to the increased competitive pressure from the public sector by increasing their quality. On the other hand, if increasing competition from the public sector reduces demand for private schools, shrinking profit margins may lead private schools to cut costs at the expense of quality. It is also possible that the selection of pupils into private school changes, as the quality of the nearby public schools evolves. We cannot fully disentangle this selection effect from a true change in quality, as the data do not allow us to

track individual pupils continuously over time. However, with a subset of the data that tracks pupils from primary to secondary school, in Section 6 we provide an analysis on characteristics that affect the likelihood of moving from a private to a public school. This suggests that our results on test scores here are less likely to be driven by a selection effect.

The summary statistics for the control and treatment groups are shown in Table 1. The two key differences between the groups are that the control group schools tend to be on average slightly larger and more expensive, based on their prices in 2020. While we do not have a time series of private school prices, we control for school fixed effects, which essentially controls for the fixed status of the school in the 'hierarchy' of private schools.

4.3 Main results

The main results for the enrolment regressions are shown in Table 2. There are two columns, one for the main specification (1) and another where the post-2011 dummy variable is interacted separately with each year, keeping 2011 as the base year. The results in the first column suggest that private school enrolment declined by approximately 8 percent in the treated schools as opposed to the control schools in the post-2011 period and the result is significant at the 1 percent level. The results in the second column indicate that the decline became statistically significant from 2015 onwards, reaching 10 percent three years after 2011, and 16.8 percent another two years later. It is logical that the impact on private schools is not immediate as one can expect there to be a lag between budget increases, improvements of facilities and academic results, and ultimately the perceptions of parents which drive the market reaction.

In Figure 8, the estimated coefficients for the treatment effects in column (2) of Table 2 are plotted against time. This provides support for the parallel trends assumption underlying the difference in differences estimation: there is no statistically significant difference in enrolment trends between the treatment and control schools prior to 2011. The divergence in enrolment begins from 2011 onwards and turns statistically significant in 2015.

Table 3 shows the results for models where the dependent variable corresponds to the average second-grade combined Reading and Mathematics test scores for private schools. The results

imply that pupils in the treated private school sample, with a nearby public sector school, had 0.11 standard deviations lower test scores. Increasing competition, if anything, appears to lead to worse test results in private schools. In principle, the negative result could arise from academically stronger pupils switching to the public sector, while the quality of the private schools remains unaffected. While this cannot be measured directly, it appears not to be supported by a subset of the data which tracks pupils over time (see Section 6).

4.4 Robustness and heterogeneity

While Figure 8 provides a visual description of the timing of the main effects**,** and supports the absence of pre-trends, we also conduct a range of alternative estimations to assess robustness. In Table 4, we carry out a falsification check, where we restrict the sample to years 2007-2011, which we deem to precede the rapid improvement of public schools. We then define a 'placebo' treatment, which is in place alternatively in the years 2009-2011 (model [1]), or years 2010-11 (model [2]). As expected, these estimations do not lead to statistically significant enrolment effects for private schools.

In Appendix Table A4 we show the equivalent results of the estimations where the treatment period is assumed to start in 2014. The headline estimate suggests a 10 percent reduction to private school enrolment during the treatment period (as opposed to 8 percent in the main specification in Table 2). The results in Table 2 are also robust to the inclusion of state-specific year effects. Such a specification may be justified by potential state-specific shocks to demand for private schooling, for example. The results, which are available upon request, indicate that the differences in relation to the main specification are rather small.

In Table 5, we estimate the model with alternative definitions for the exposure to public sector competition. In the main specification, we classified private schools which have no public competitors within a 1km radius, as 'not treated'. We alter this distance to 0.5km or alternatively 1.5km. The key assumption is that there must be a natural distance in high-density areas after which schools compete significantly less with each other. Earlier work confirms that the proximity of schools is very important for safety-conscious parents (Balarin 2015). On the other hand, since there is an abundance of primary schools, both public and private, it is fairly difficult to find private schools with a long distance to any public schools, leading to a selected

sample. In Table 5, using 0.5 km instead of 1 km yields somewhat smaller coefficients, which however are strongly significant at the 1 percent level. Moving to a 1.5 km radius also yields negative coefficients with a similar magnitude, but they are no longer statistically significant. One reason for this could be that only 0.75 percent of private schools are this distant from public schools, leading to a very selected treatment sample and weaker statistical power.

In Table 6, we estimate the main treatment effects for sub-samples that may contain more families on the margins of deciding between public and private schools. We divide the sample by the average district level of education for adults (proxying for socio-economic status), and secondly, by school-specific test scores of private schools in 2011 and replicate the main estimation in Table 2 for these two split samples. We would expect areas with on average lower socio-economic status to be more elastic in their choice, and that private schools that have weaker results would be under more pressure as the public sector improves. The results support the first expectation; columns 1 and 2 of Table 6 show that the reduction in demand is focused on private schools in areas with lower adult education levels. However, there is no evidence on differential effects according to private school quality. In columns 3 and 4, we observe that the estimate for the treatment effect is negative and similar for private schools with both weaker and stronger test scores in grade 2.

It should also be recognized that urban public schools may be at capacity and not able to take new pupils, despite increased demand. For Table 7, we first calculate the average public school pupil-teacher ratio (PTR) in the 2km radius of each private school in the treatment group. We then divide the sample of private schools on the basis of this PTR average; namely to bottom 50% (least crowded public schools nearby), the 50^{th} to 90^{th} percentile, and the top 10 percentiles (most crowded). We then estimate the main model (as in Column 1 of Table 2) for these sub-samples. We find that in the first two sub-groups, private enrolment declines by 8.5 percentage points, but in the final group, in which the PTR of public schools is over 28.5 pupils per teacher, the estimate is -4.2 percentage points, and no longer statistically significant. This lends support to the view that pupils were more able to move from the private to the public sector when the local public sector faced less capacity constraints. This in turn suggests that had there been more capacity in the public sector, the private sector might have experienced an even larger fall in enrolment in response to an improving public sector.

Finally, we divide the sample between Lima, and other urban areas. This is to reflect the fact that labor markets, levels of wealth and development differ substantially between Lima and the rest of the country. Public schools in Lima are also funded from the central government budget instead of the regional budgets. The results (Appendix Table A5) show that the estimated effects are larger in urban areas outside Lima, but nevertheless statistically significant for both groups at 5% level.

Overall, the results from a range of robustness checks echo the findings of the main analysis. They also indicate that the fall in enrolment in response to public sector improvement was concentrated in areas with on average lower socio-economic status, and in areas with sufficient capacity in public schools.

5 Evidence from public school openings

An alternative way to examine the effect of public schools on the private sector is to focus on the effects of public school openings. Using the precise locations of new schools, we can assess how the nearby private schools are affected. This does not focus on the public sector quality improvement directly, but captures more of a quantity effect (extensive margin). However, if there was a general improvement in public sector learning since 2011, this should also be reflected in the quality of the new schools.

An immediate concern with this exercise is that the locations where new public schools are built are of course not exogenous. We address this by selecting the treatment and control groups within the vicinity of the new public school. Namely, we consider private schools within 1km to be 'treated' and those within 1-2kms as the 'control' schools. The treatment and control schools are thus practically in the same local area.

Between 2008-2019, we observe 1801 new public primary school openings. However, most of these take place in rural areas, or other areas where no private schools are present. In fact, only 186 of these openings have private schools nearby. Furthermore, for the sake of tractability, we trim our sample of affected private schools to ones that experience only one new public school opening in their vicinity (and not more than one). This leaves us with a sample of 129 public school openings, with 1204 private schools within a 2-km radius of one of these

openings. Of these, 393 are within a 1 km radius and counted as 'treated'. The rest, 811 are the ones within 1-2kms, and are used as the control group (see Table 8).

To estimate the effect of public school openings on local private schools, a traditional two-way fixed effects estimation (TWFE) would follow the form

$$(4)\ \ln(\text{Enrolment}_{it}) = \beta_1 \text{Post}_{it} \times \text{Opening}_{it} + \lambda_i + \theta_t + \varepsilon_{it}$$

Here, the dependent variable is the log of private school enrolment (or an alternative outcome), which is explained by a dummy 'Opening_{it}', which indicates that a school was opened in the vicinity of the private school. The "Post" dummy variable indicates the years (for each private school separately) after the new public school appeared, so as to estimate the average yearly effect on the dependent variable. The equation controls for private school fixed effects (λ_i) and year dummies (θ_t).

As pointed out by recent advances in econometrics, the specification (4) would produce unreliable estimates in the presence of heterogeneous treatment effects across time (for surveys, see de Chaisemartin and D'Haultfouille, 2023 or Roth et al, 2023). Given the rapid improvement of public schooling over the examined period, it seems highly probable that parameter β_1 in (4) would be different for earlier and later school openings, leading the TWFE to be a misguided choice for identification. We will therefore base our identification on the staggered difference-in-differences estimator (DiD) by Callaway and Sant'Anna (2021).

The results for the TWFE and staggered DiD models for private school enrolment are shown in Panel A of Table 9. The first column presents the results for the full sample, and the second and third for openings between 2008-2011, and openings from post-2011 onwards respectively. The first period reflects the pre-reform years and the second the reform period. Firstly, the two methods produce strikingly different results. The results of the staggered DiD are consistent with the facts established in the previous sections; the opening of new public schools had a larger negative impact on private school enrolment, as public schools improved over time. The TWFE estimates are substantially different, with even a different sign, which is possible and expected under considerable heterogeneity of treatment effects (Roth et al, 2023).

We find that in the early part of the sample, public school openings had a negative, but insignificant effect of four percent on private enrolment for schools within a 1km radius. However, for openings since 2012, the estimated effect corresponds to a 8.5 percent reduction, which is significant at the 10 percent level.

The dynamic effects of the full sample estimation by year are plotted in Figure 9. This plot allows for the evaluation of the 'parallel trends' assumption which appears to be satisfied; in the pre-treatment period, there is no trend-like decline in private school enrolment, and the significant negative effects appear only after the public school opening.

Panel B of Table 9 shows the results of the DiD estimates, when the outcomes of interest are the mean test scores of second graders in private schools. We find no evidence that the results would have changed due to the opening of new public schools, neither for the full sample or the subsamples.

As in Section 4.2, it is expected that parents who are closer to the margin of choosing between the public and the private sector, will be more sensitive to the appearance of new nearby public schools. In Table 10, the sample has firstly been divided into districts with lower and higher levels of education (defined as having more or less than median years of education for adults in 2007) and secondly, to private schools above and below the local median level of learning (as defined by the sum of Reading and Mathematics scores in the year before the public school is opened in the local area 2km within the new public school). In short, we would expect the response to school openings to be larger in districts with lower levels of education (due to lower socio-economic status), and larger in private schools that are of worse quality.

The results in Tables 10 confirm these hypotheses. In districts with a lower level of adult schooling, the opening of public schools within a 1km radius leads to a 9 percent reduction in enrolment, which is statistically significant, whereas there is a smaller and statistically insignificant effect in areas with higher levels of education. For schools with below median results, we find a significant reduction of 11 percent in enrolment, whereas for schools with better scores, the effect is smaller and statistically insignificant. Both split samples were estimated with all school openings in the data to maintain sufficiently large samples. However, these average treatment effects may hide heterogeneity over time, as was seen in Table 9.

Overall, the evidence from Sections 4-5 together suggests that changes in both the quality and quantity of public schooling have an impact on local private schools. The rapid improvement in quality after 2011, led to lower private school enrolment, unless these schools were shielded from competition by distance. The results appear to be driven especially by areas with lower than average levels of adult education, proxying for socio-economic status. For school openings, the effect is also concentrated on private schools with on average lower test scores, which is also expected.

6 Evidence from pupil panel data

The analysis so far has focused on school level data. In this Section, we complement it with pupil-level data. The school level changes that we have observed in the last two sections are the result of families increasingly choosing public over private schools or switching from private to public schools. The analysis in this Section serves several purposes. Firstly, it serves to confirm the enrolment response to public school improvement with pupil level data. Secondly, it provides evidence on the determinants of switching from a private primary school to a public secondary school, and thus an indication of the type of pupils who switch to public sector school. This in turn can shed light on the role that selection of pupils might play in explaining the negative effect of the reform on private sector test scores in Section 4.

We have so far relied on enrolment and test scores in grade 2 of primary school, which is available for all pupils and schools. In addition, a longitudinal dataset that tracks pupils and their test scores in grades 2 and 8, is available for four cohorts (2009-15, 2010-16, 2012-17 and 2013-2019) for a subset of pupils. The analysis in this Section is based on this subset of data. The panel covers pupils who were in the second grade of primary school in 2009, 2010, 2012 and 2013, and subsequently in the eighth grade, or the second year of secondary school in 2015, 2016, 2018 and 2019. While the 8-graders represent a full sample of the respective cohorts, about 70-80 percent of the pupils can, depending on the cohort, be matched to their primary school information. The sample is slightly tilted towards pupils from urban, larger primary schools.

For our estimations, we restrict the sample only to pupils who were in urban primary and secondary schools, as there are few private schools in rural areas. Table 11 provides summary

statistics for the whole urban sample, and separately for a sub-sample of pupils who went to a private primary school. Test scores and the Socioeconomic Status (SES) index have been nationally normalized. The SES index is only available for eight graders and therefore has not been used in our main analysis.[4]

To analyze the decision to move from a private primary to a public secondary school, we estimate the following pupil-level (i) linear probability model

$$(5) \qquad P(Switch_i|\boldsymbol{X}_i) = \delta_c + \boldsymbol{X_i\theta} + \lambda I_l + v_i,$$

in which we focus on the likelihood of switching to a public sector school from a private primary school ($Switch_i$). Since pupils are only observed in grades 2 and 8, we do not know exactly when they switched between the private and public sector. It is however reasonable to assume that in most cases, the switching takes place in grade 7 when the secondary school begins.

With respect to the educational reforms, we can assume that the later cohorts were more exposed. The last two cohorts, tested in 2012 and 2018, and 2013 and 2019, were quite strongly affected, whereas the first cohort, tested in 2009 and 2015 (which is used as the reference group), was only partially affected. We rely on this distinction to capture the role of the reforms: namely the cohort effects δ_c will reveal whether switching to the public sector becomes more prevalent as the reforms progress. We expect later cohorts to have larger cohort effects.

The vector $\boldsymbol{X_i}$ includes pupil SES from the eighth grade and test scores from grade 2. The coefficients for these provide an idea of the type of pupils that generally switch from private to public schools. We also include a measure of how much local primary public schools improved near the pupil's primary school (I_l), where l refers to the local area. I_l is measured as the mean second grade test score improvement during four years of the pupils' primary school, averaged over all public primary school pupils within a 2km radius of the pupil's own primary school. For example, for the 2009-15 cohort, this is calculated as the average improvement in the

[4] The average value of the SES Index, 0.376, shows that by restricting the sample to urban schools, we are selecting pupils disproportionately from higher SES groups. In the sample, 35.6% attend private primary school, and about a quarter of these switch to a public secondary school. The mean SES Index of pupils in private primary schools is 0.875 standard deviations above the national average (of zero).

normalized second grade Reading+Maths score between 2009 to 2012 (grades 2-5)[5]. The pupil is surveyed for the second time in 2015 and entered the current secondary school in 2014. The coefficient for I_l allows us to gauge whether local families are responsive to the improvement of the public sector in their immediate neighborhoods.

As an extension to (5), we estimate a model where the cohort dummies are interacted with I_l. The purpose is to measure whether the elasticity of parents to the improvement of public sector schools in the area became larger over time, as improvements in public schools become more prevalent or visible. All these estimates require that the standard errors are corrected for spatial clustering within 2km of each primary school, which has been implemented using Colella et al (2023).

The results are shown in Table 12. In the first column, the coefficients on the cohort dummies indicate that switching from a private to a public school became more prevalent among the later cohorts, which is consistent with the progression of the public sector reforms. In terms of selection, pupils with weaker test scores and lower parental SES were more likely to switch to the public sector in general. This is a general association, and not specific to the reform period. It nevertheless suggests that the negative effect of the reform period on private sector test scores in Section 4 is unlikely to be explained by selection, namely by better pupils leaving private sector schools. We also find that the improvement in the local public primary schools has a positive effect on the likelihood of switching, which corroborates the hypothesis that parents are responsive to the changes in the public sector.

The results in the second column suggest that the later cohorts that are more influenced by the reform period, are more responsive to the local improvement of public schools. The final cohort, tested in 2013 and 2019, is 6-7 percentage points more responsive to a 1 standard deviation improvement in local public schools, than the first two cohorts. Overall, both columns lend support to the conclusion that public sector reforms made pupils opt for public schooling, and that the local public sector improvement, which may have been partly observed by parents, mattered.

[5] The improvement is calculated from grades 2-5, and not 2-6, since the 6th year data point is not available to us for the final cohort observed in 2013-19, since the last year of primary school test score data that we have is 2016.

7 Discussion and conclusions

Over the 2010s, Peru's education budget increased significantly and a number of educational reforms were implemented. This led to a substantial improvement in the quality of public primary education, as measured by both test scores and observable school infrastructure.

In urban areas, which are already largely built-up, this period was characterized by an increase in the quality or average test scores of public schools as opposed to a large increase in the number of public schools. This provides an interesting setting to examine the effects of public sector improvement on the division of the primary education market between the public and private sectors. Due to a liberal regulatory environment, private schooling had, prior to these reforms, grown in size and increased its market share in urban Peru.

Firstly, we document how over a relatively short window of about 4-5 years, beginning from 2011, the private sector learning premium in urban primary schools by grade 2 largely vanished. By 2016, only the more expensive private primary schools could match the learning outcomes of public schools.

Leveraging geocoded school data, we create a control group of private schools, which due to their location, faced substantially less competition from the improving public sector. In a difference in differences framework, we estimate that the increased competitive pressure from the public sector led to a 10 percent fall in private school enrolment after four years, and a 17 percent fall after seven years. Further estimates show that this effect was nearly completely driven by census districts which had lower parental educational levels. This suggests that parents with less resources were more responsive in their choice of school and helped to reverse the trend of private sector growth in urban Peru.

We find no evidence that private schools would have improved their quality as a response to improving public schools. On the contrary, our findings indicate that average learning outcomes declined in affected private schools. However, these data do not allow us to credibly isolate whether this is due to pupil selection as a result of public sector reforms.

In the second analysis, we examine the impact of the opening of new public schools on nearby private schools using a staggered difference-in-difference specification. While this analysis mainly concerns the supply effect of public schooling, rather than a quality effect, we also know that as the public sector quality was improving over time, there may be significant heterogeneity in the effect of public school openings on private schools over time. We consider private schools which are closer than 1km to opening schools to be 'treated', while those within 1-2kms are 'control' schools, using staggered DiD by Callaway and Sant'Anna (2021). The results indicate that private schools lost on average 8.5 percent of pupils to newly opened public schools after 2011, but before that, the effect was not significant. Further, we find evidence that the negative impacts on private schools were concentrated on areas with lower levels of education, and on private schools that were academically weaker.

Finally, a panel data analysis of pupils indicates that an improvement in the quality of local public sector schools is associated with pupils being more likely to switch from a private primary school to a public secondary school. As the reforms progress, pupils become more likely to switch to public sector. Further, this analysis reveals that pupils moving from the private to the public sector have lower test scores than the private school average and come from a lower socio-economic background. This implies that selection of pupils is unlikely to be driving our earlier results on the negative effect of public school improvement on learning in private schools.

Overall, the results show that a comprehensive educational reform and increase in funding has the potential to rapidly improve educational attainment from a low base level in the public sector and crowd out private schools. Globally, such reversals have been unusual, as low-fee private schooling has been gaining market share.

In Appendix C, we conduct a simple value for money calculation for the public sector education in Peru. This suggests that in the post 2011 period, the improved learning outcomes were produced at a cost that is favorable compared to what could have been achieved by the private sector. The calculation suggests that a potential voucher scheme, where the state would fund enrolment in private schools, would be relatively expensive, if the aim were for private schools to produce on average similar quality of education as public schools. These results echo the findings of Rentería (2023), who found that a rapid expansion of private schooling in Peru since 1996 has not led to improved skills or labor market outcomes.

Private education has been expanding rapidly in many emerging economies as parents have discovered that public sector education does not meet their needs. The Peruvian case in the 2010s provides an example of public investment that was able to reverse this trend. This in turn is positive news for those concerned about school systems and the 'learning crisis' in developing countries (World Bank, 2018).

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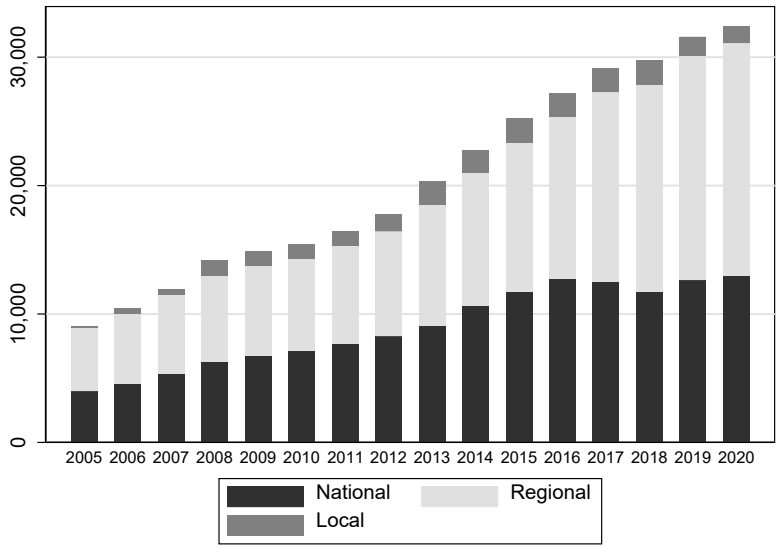
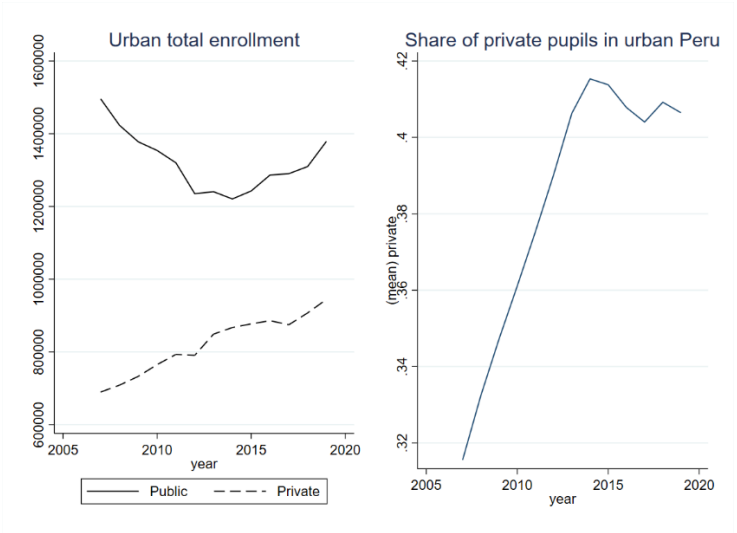
Figure 1 Total budget allocated to education in 2005-2020, millions of Soles



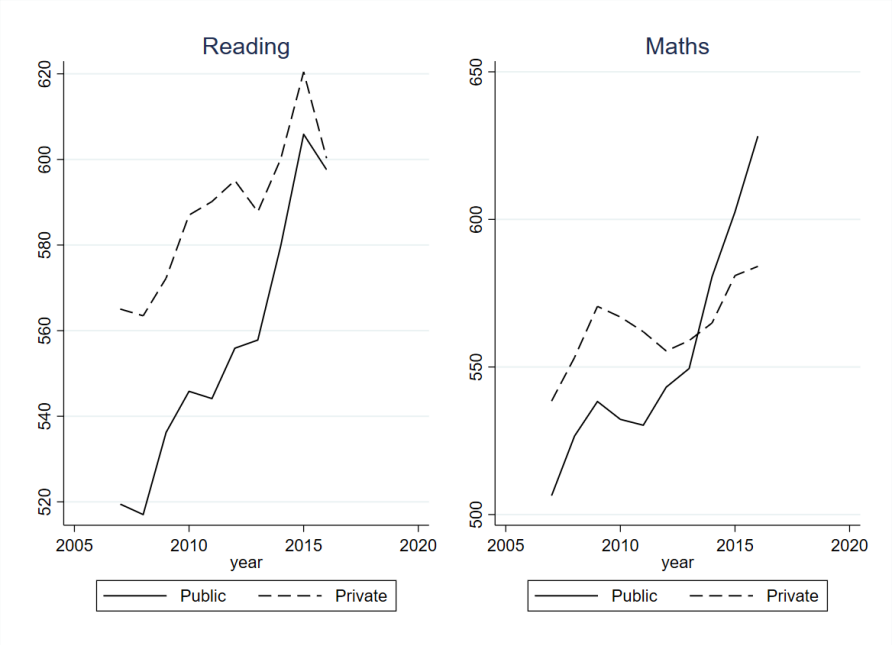
Source: Authors' calculations based on data from the Portal de Transparencia del Ministerio de Economía y Finanzas (Ministry of Economy and Finance).

Figure 2 Trends in private and public primary schooling in urban Peru



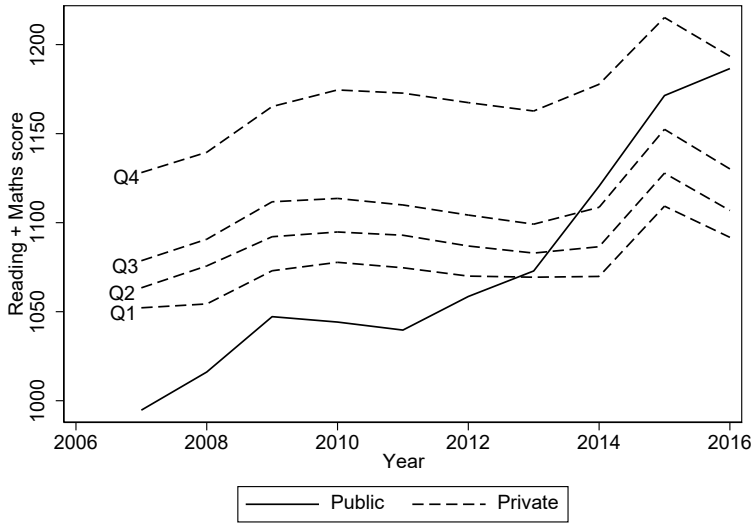
Notes: The sample, 'urban Peru', is defined as 261 districts, which in the census of 2006, had urbanization rate of at least 80 percent.

Figure 3 Grade 2 test scores in private and public schools in urban Peru



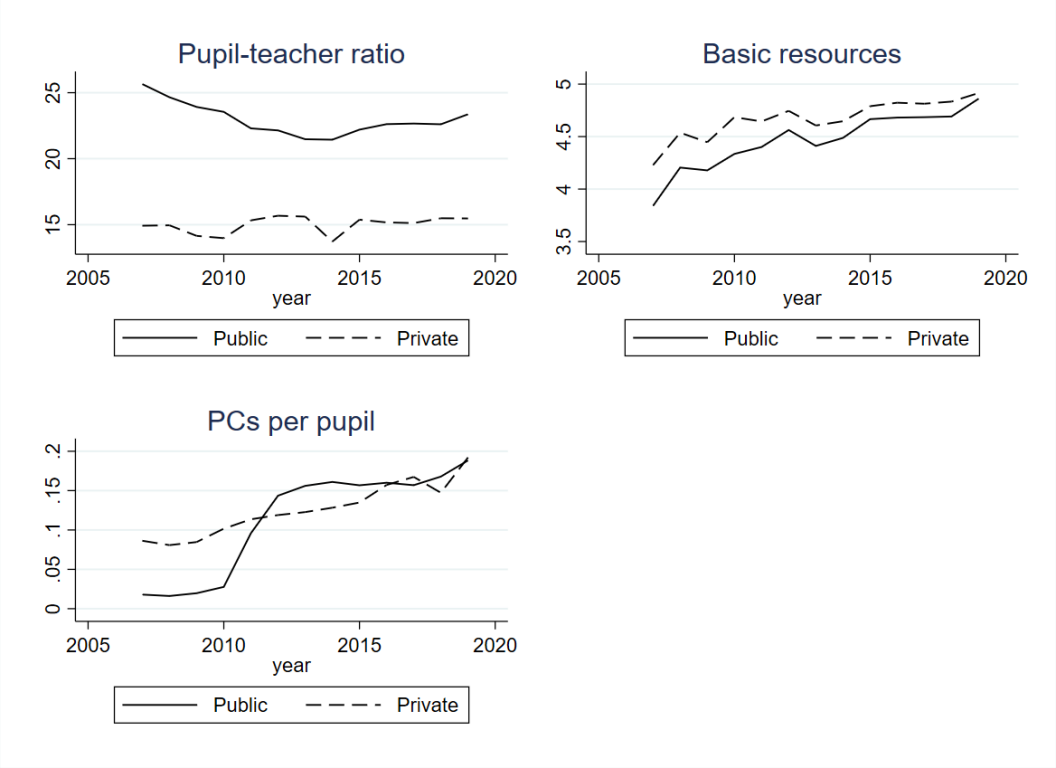
Notes: Sample – districts that were at least 80 percent urban in 2007.

Figure 4 Grade 2 test scores by quantiles of private school fees, compared to public sector schools (urban districts)



Notes: Price quartiles are Q1: 1-140 Soles, Q2: 141-180 Soles, Q3: 181-260 Soles, Q4: Over 260 Soles, no price. Prices are from 2020, and thus indicative. They are not available for the period studied (Identicole website: https://identicole.minedu.gob.pe/).

Figure 5 Developments in basic school resources in public and private sector (urban districts)



Basic resources refers to an index of five items: water, sewage, electricity, toilet and internet. Each school is rated between 0-5, and the values averaged across districts by year, weighted by pupil numbers.

Figure 6 Number of competitor schools within 1km of urban private schools, 2011.

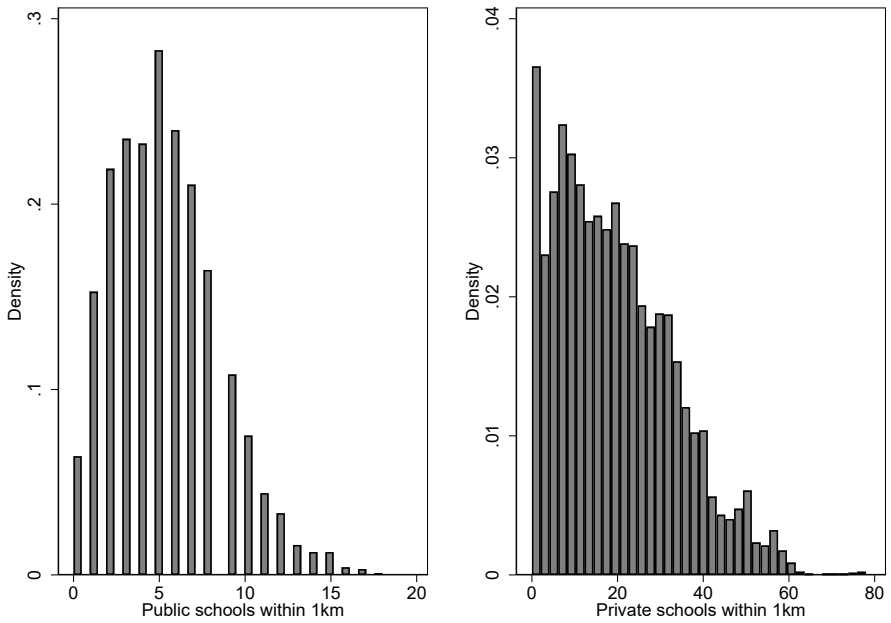


Figure 7a Density of private and public schools in and around Lima

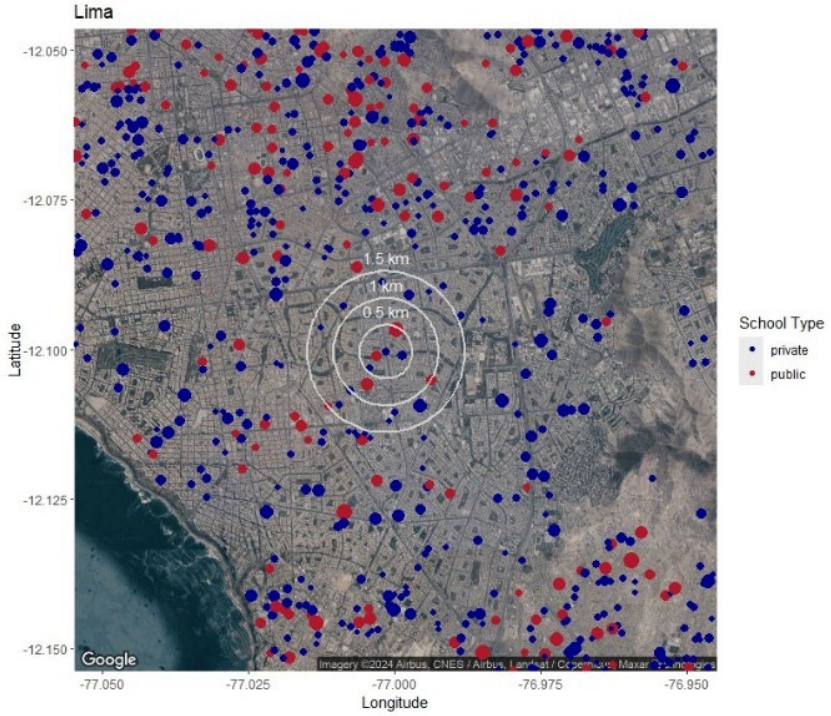


Figure 7b Density of private and public schools in and around Lima

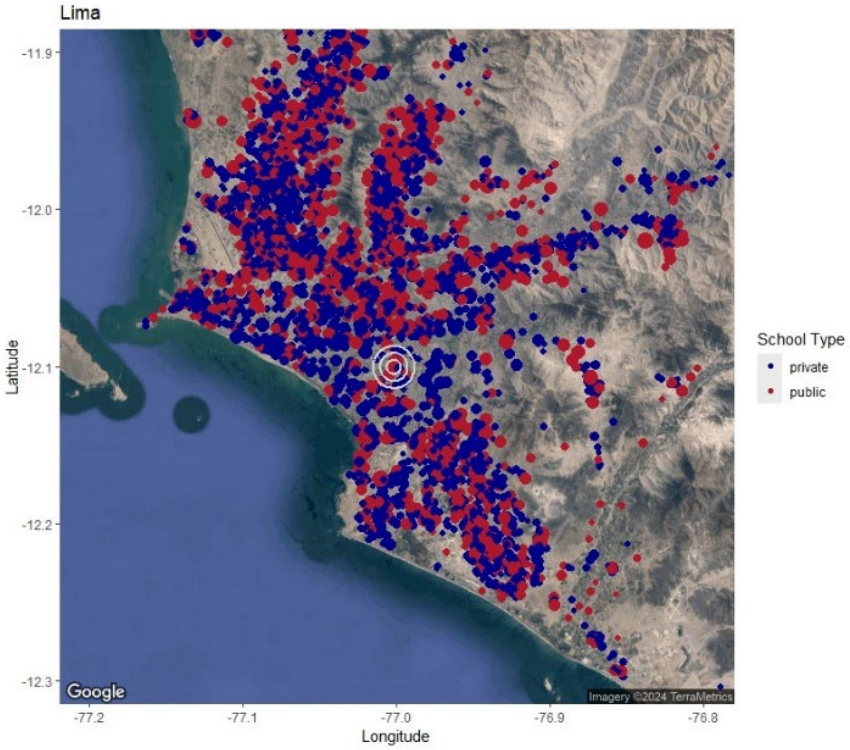
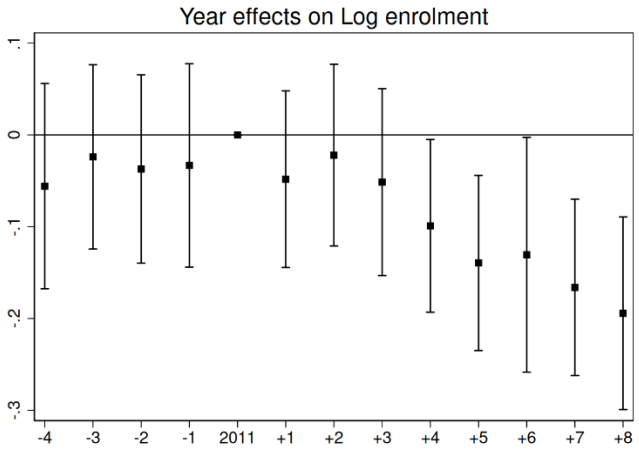
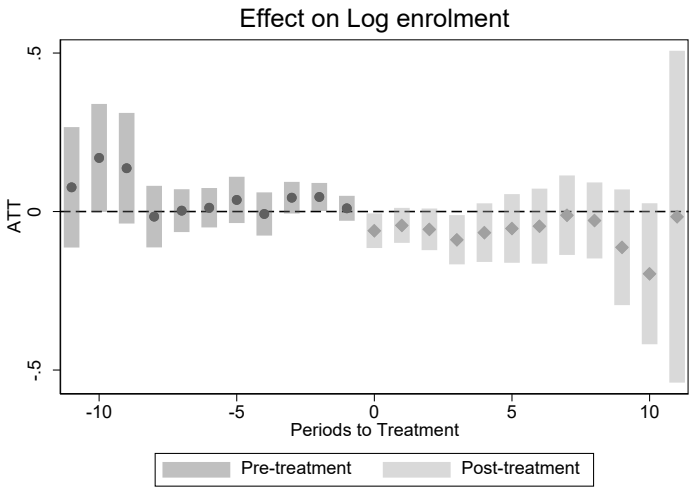


Figure 8 Annual treatment effects on enrolment, compared to 2011.



Notes: The coefficients represent the estimates from Table 2, column 2.

Figure 9 Estimated dynamic impact of public school opening on private school enrolment within 1km of the opening.



Notes: Estimates based on DiD event estimates using *csdid* package in STATA. The average post-treatment effects are reported on Panel A of Table 9.

Table 1 Summary statistics for treatment and control groups

	Control (n = 2508)				Treatment (n = 87946)			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
School data								
Year	2013.7	3.7	2007	2019	2013.4	3.7	2007	2019
Enrolment	143.9	157.0	1	952	115.0	133.5	1	1597
Urban school	0.93	0.26	0	1	0.99	0.11	0	1
Maths+Reading score	1155	120	775	1487	1113	101	405	1674
Monthly price (2020)	610	1380	1	16000	234	290	1	12010
P/T ratio	14.5	20.5	0.3	858	13.8	10.9	0.2	712

Notes: The control group consists of private schools with no public sector competitor(s) within a 1km radius.

Table 2 Difference in difference estimates

	[1] Ln (Enrolment)		[2] Ln (Enrolment)	
	Coef.	T-stat.	Coef.	T-stat.
Post × Treat	-0.081**	[-3.376]		
Year 2007	-0.084**	[-8.480]	-0.028	[-0.486]
Year 2008	-0.047**	[-5.260]	-0.017	[-0.336]
Year 2009	-0.040**	[-4.657]	-0.004	[-0.077]
Year 2010	-0.021*	[-2.523]	0.013	[0.229]
Year 2012	0.096**	[3.918]	0.066	[1.343]
Year 2013	0.123**	[5.034]	0.069	[1.372]
Year 2014	0.125**	[5.101]	0.108*	[2.082]
Year 2015	0.107**	[4.377]	0.133**	[2.826]
Year 2016	0.108**	[4.380]	0.164**	[3.397]
Year 2017	0.036	[1.450]	0.09	[1.388]
Year 2018	0.097**	[3.893]	0.182**	[3.716]
Year 2019	0.165**	[6.608]	0.276**	[5.181]
Year 2007 × Treat			-0.057	[-0.996]
Year 2008 × Treat			-0.031	[-0.600]
Year 2009 × Treat			-0.036	[-0.690]
Year 2010 × Treat			-0.035	[-0.609]
Year 2012 × Treat			-0.05	[-1.002]
Year 2013 × Treat			-0.025	[-0.501]
Year 2014 × Treat			-0.063	[-1.202]
Year 2015 × Treat			-0.107*	[-2.260]
Year 2016 × Treat			-0.138**	[-2.840]
Year 2017 × Treat			-0.136*	[-2.073]
Year 2018 × Treat			-0.168**	[-3.395]
Year 2019 × Treat			-0.195**	[-3.627]
Observations	90,454		90,454	
R-squared	0.827		0.828	

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects.

Table 3 Effect of public competition on test scores in private schools

	Learning (z)	
	Coef.	T-stat.
Post × Treat	-0.115**	[-4.917]
Year 2007	-0.227**	[-22.68]
Year 2008	-0.168**	[-18.38]
Year 2009	-0.024*	[-2.543]
Year 2010	0.015+	[1.716]
Year 2012	0.082**	[3.427]
Year 2013	0.072**	[3.027]
Year 2014	0.124**	[5.083]
Year 2015	0.393**	[15.96]
Year 2016	0.263**	[10.78]
Observations	54,926	
R-squared	0.5959	

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects and year effects. Learning outcomes are available for years 2007-2016 only and represent combined Mathematics and Reading scores.

Table 4 Robustness to alternative timing of the treatment

Pre-treatment placebos (Sample 2007-2011)				
		Coef. [T-stat]	Obs	R-Squared
[1]	Post 2008 × Treat	-0.021	30,728	0.907
		[-0.961]		
[2]	Post 2009 × Treat	-0.023	30,728	0.907
		[-0.975]		

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects and year effects.

Table 5 Robustness to altering the definition of treated

		Coef. [T-stat]	Obs	R-Squared	Share treated
[1]	Post 2011 × Treat (0.5km)	-0.064**	90,454	0.828	0.8119
		[-6.888]			
[2]	Post 2011 × Treat (1.0km)	-0.081**	90,454	0.827	0.9726
		[-3.376]			
[3]	Post 2011 × Treat (1.5km)	-0.067	90,454	0.827	0.9925
		[-1.508]			

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects and year effects.

Table 6 Treatment effects for sub-samples by local level of education and private school quality

Dependent: ln(Enrolment)	[1]	[2]	[3]	[4]
	Local edu level		Priv school results	
	Lower 50%	Top 50%	Lower 50%	Top 50%
Post × Treat	-0.158**	0.019	-0.119**	-0.103**
	[-4.756]	[0.581]	[-2.640]	[-5.056]
Observations	46,204	44,250	34,192	34,965
R-squared	0.814	0.843	0.749	0.868

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects and year effects. Local level of education is by district using census 2007, with the median cutoff as 9.01 years of education. Private school results use a cutoff of 1109.2 for combined reading + maths test score in 2011.

Table 7 Capacity constraints: Treatment effect by the pupil-teacher ratio of nearby public schools

	Local public PT-Ratio		Coef. [T-stat]	Obs	R-Squared
[1]	Below median (under 26.6)	Post 2011 × Treat	-0.085**	42,448	0.842
			[-3.529]		
[2]	50-90th percentile (between 26.6-28.5)	Post 2011 × Treat	-0.085**	33,909	0.824
			[-3.478]		
[3]	Top 10% (above 28.5)	Post 2011 × Treat	-0.042	10,425	0.815
			[-1.573]		

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using acreg in STATA. All models include school fixed effects and year effects. Local public PT-ratio is calculated prior to treatment (in year 2011) as an average PT-ratio of all public school within 1km of the 'treated' private schools in the sample.

Table 8 Number of public school openings and private schools in their vicinity.

Number of observations	
Relevant public school openings (2008-2019)	129
Private schools within 1 km (Treatment)	393
Private schools within 1-2km (Control)	811
Total private schools (Treatment + Control):	1204
Total observations over 2007-2019:	13374

Table 9 Effect of public school openings on private schools

Panel A: Ln Enrolment	All openings	Openings 2008-11	Openings 2012-
TWFE			
Within 1km	0.0048	-0.0343	0.0583+
	[0.2398]	[-1.2411]	[1.9388]
Observations	13374	6338	7036
DID (Callaway & Sant'Anna 2021)			
Within 1km	-0.0599+	-0.0345	-0.0854+
	[-1.9071]	[-0.7723]	[-1.8857]
Observations	13269	6245	6982
Panel B: Combined score (z)			
DID (Callaway & Sant'Anna 2021)			
Within 1km	-0.0375	0.0199	0.0785
	[-0.6079]	[-0.2671]	[0.8704]
Observations	7935	3956	3882

Notes: (+): $p < .1$, (*): $p < .05$, (**): $p < .01$. T-statistics in parenthesis. All models control for school and year fixed effects. DiD implemented with *csdid* package in STATA, reporting the ATT. Sample for test scores is lower due to test scores not being available for 2017-19.

Table 10 Effect of public school openings on private school enrolment by district level of education and by relative local private school test scores

Ln Enrolment	**Local level of education**	
DiD (Callaway & Sant'Anna 2021)	Lower	Higher
Within 1km	-0.0927**	-0.0260
	[-2.0823]	[-0.5791]
Observations	7050	5794
	Private school test score	
	Lower	Higher
Within 1km	-0.1120**	-0.0454
	[-2.2135]	[-1.1913]
Observations	4183	4899

Notes: (+): $p < .1$, (*): $p < .05$, (**): $p < .01$. T-statistics in parenthesis. All models control for school and year fixed effects. DiD implemented with *csdid* package in STATA, reporting the ATT. 'Lower/Higher education' refers to districts with mean years of adult education below/above 8.96 years in 2007 Census. 'Lower/Higher test score' refers to private school having lower/higher test score compared to local median of private schools scores within 2km of the opening public schools in the year before the school opens. Sample for test scores is lower due to test scores not being available for 2017-19.

Table 11 Summary statistics for the panel data of pupils

Panel A: Full urban sample				
n = 966,185	Mean	S.D.	Min	Max
Reading (z, grade 2)	0.107	1.044	-6.00	3.26
Mathematics (z, grade 2)	0.058	1.121	-5.33	4.10
Reading VA grades 2-8 (z)	0.041	0.909	-7.920	7.036
Mathematics VA grades 2-8 (z)	0.061	1.002	-8.066	6.623
Mover from public to private	0.060	0.238	0	1
Mover from private to public	0.091	0.288	0	1
Private primary school	0.356	0.479	0	1
Pupil SES index	0.376	0.810	-3.480	9.354
Panel B: Pupils attending private primary school				
n = 346,613	Mean	S.D.	Min	Max
Reading (z, grade 2)	0.374	1.040	-6.00	3.26
Mathematics (z, grade 2)	0.128	1.114	-5.33	4.10
Reading VA grades 2-8 (z)	0.098	0.900	-7.920	7.036
Mathematics VA grades 2-8 (z)	0.262	0.962	-7.438	6.414
Mover from public to private	0	0	0	0
Mover from private to public	0.254	0.435	0	1
Private primary school	1	0	1	1
Pupil SES index	0.875	0.575	-3.272	3.997
Local public improvement (z)	0.602	0.441	-2.451	3.667

Notes: SES index is pupil-specific normalised index of SES. Local public improvement is measured as the average public primary school improvement within 2km radius of the pupil's own primary school over grades 1-4 measured in Z-score of Reading+Mathematics score.

Table 12 Determinants of private-public switch between primary and secondary schools

Sample: In private primary school	[1]		[2]	
Dependent: Switch to public secondary	Coef.	Z-stat.	Coef.	Z-stat.
Pupil SES index	-0.236**	[-44.170]	-0.234**	[-46.387]
Cohort 2010-16	0.021**	[6.084]	0.020*	[2.427]
Cohort 2012-18	0.037**	[5.637]	0.008	[0.359]
Cohort 2013-19	0.022**	[3.076]	-0.018	[-1.097]
Local public improvement (z)	0.028**	[2.704]	-0.012	[-0.571]
Local pub. impr. (z) x Cohort 2010-16			0.001	[0.050]
Local pub. impr. (z) x Cohort 2012-18			0.063+	[1.718]
Local pub. impr. (z) x Cohort 2013-19			0.073**	[2.600]
Constant	0.422**	[44.319]	0.432**	[37.906]
Observations	346,613		346,613	
R-squared	0.102		0.103	

Notes: ** p<0.01, * p<0.05, + p<0.1. Z-statistics adjusted for spatial correlation. Linear probability models. SES index is pupil-specific normalised index of SES. Local public improvement is measured as the average public primary school improvement within 2km radius of the pupil's own primary school over grades 1-4 measured in Z-score of Reading+Mathematics score. The reference cohort is the cohort 2009-15 (observed in 2nd grade in 2009, and 8th grade in 2015).

APPENDIX A: Selection of schools due to availability of geolocation

Data on the location of schools in the form of coordinates is available from 2016 onwards. In our econometric analysis, we are limited to a sample of schools, for which these location data are available prior to 2016. In other words, we are constrained to using schools which still existed in 2016. Schools which closed over 2007-2015 are thus dropped from the sample.

Over 2007-2015, a total of 1111 private schools closed. This represents an average annual exit rate of slightly under 0.6 percent. In the table below, the likelihood of exit is regressed on key school characteristics, year effects, and region effects, using a linear probability model.

Table A1 The likelihood that a private school closes, 2007-2015

	P(School closes)	
	Coef	T-statistic
Enrolment	-0.000015**	[-4.737207]
Urban school	0.001657	[0.723519]
Reading score	-0.000003	[-0.192363]
Mathematics score	-0.000016	[-1.507880]
Electricity	-0.008261**	[-2.758229]
Water	0.001867	[0.757746]
Sewage	0.001145	[0.459929]
Toilet	-0.004377*	[-2.389747]
Internet	-0.002348**	[-2.586214]
Year 2008	0.001201	[0.810083]
Year 2009	-0.001094	[-0.716714]
Year 2010	-0.005168	[-1.033520]
Year 2011	-0.001106	[-0.225484]
Year 2012	-0.001426	[-0.290029]
Year 2013	-0.000914	[-0.621998]
Year 2014	-0.001085	[-0.734587]
Year 2015	0.000047	[0.030922]
Constant	0.027165**	[5.133118]
Department FE	Yes	P(F-test): 0.026
Observations	36,374	
R-squared	0.003802	

Notes: (+): $p < .1$, (*): $p < .05$, (**): $p < .01$. The mean of the dependent variable in the sample is .0059383.

It is noteworthy that the year effects, especially post-2011, are predicting exit. This alleviates a worry that closure of private schools due to the reform prior to the introduction of geolocation data would have biased the main sample.

APPENDIX B: Additional Tables

Table A2: Regional educational spending and salaries in Peru 2009-19

	Spent (Millons Soles)		Annual % growth	
Year	Total	Salaries	Total	Salaries
2009	6366	5302	.	.
2010	6577	5270	3.3%	-0.6%
2011	7072	5561	7.5%	5.5%
2012	7766	5996	9.8%	7.8%
2013	9005	7193	16.0%	20.0%
2014	9828	8029	9.1%	11.6%
2015	11078	8614	12.7%	7.3%
2016	11949	9591	7.9%	11.3%
2017	14125	11208	18.2%	16.9%
2018	15308	12568	8.4%	12.1%
2019	16648	13583	8.8%	8.1%

Notes: Source: MEF. Figures refer to regional spending (Gasto regional). Salaries are a subcategory of spending labelled 'Personal y obligaciones sociales', and they do not include pensions.

Table A3 Cohort Sizes in Population Census 2017

Age	Population	Year start school
5	511,262	2019
6	516,416	2018
7	535,534	2017
8	547,909	2016
9	535,203	2015
10	511,922	2014
11	532,947	2013
12	544,366	2012
13	523,192	2011
14	501,000	2010
15	483,528	2009
16	476,818	2008
17	489,932	2007

Notes: The table shows the numbers of 5-17 year olds in the 2017 census, and the approximate year of starting school for each of these cohorts.

Table A4 Difference in difference estimates, alternative start year 2014

	[1] Ln (Enrolment)		[2] Ln (Enrolment)	
	Coef.	T-stat.	Coef.	T-stat.
Post × Treat	-0.103**	[-4.701]		
Year 2007	-0.128**	[-14.385]	-0.097+	[-1.706]
Year 2008	-0.091**	[-10.363]	-0.086	[-1.539]
Year 2009	-0.084**	[-9.636]	-0.073	[-1.337]
Year 2010	-0.065**	[-7.598]	-0.056	[-1.048]
Year 2011	-0.044**	[-5.229]	-0.069	[-1.319]
Year 2012	-0.027**	[-3.146]	-0.003	[-0.066]
Year 2014	0.102**	[4.481]	0.039	[0.758]
Year 2015	0.084**	[3.688]	0.064	[1.278]
Year 2016	0.085**	[3.716]	0.095+	[1.903]
Year 2017	0.014	[0.593]	0.021	[0.429]
Year 2018	0.074**	[3.248]	0.113*	[2.291]
Year 2019	0.142**	[6.219]	0.207**	[4.207]
Year 2007 × Treat			-0.032	[-0.553]
Year 2008 × Treat			-0.005	[-0.094]
Year 2009 × Treat			-0.011	[-0.198]
Year 2010 × Treat			-0.009	[-0.170]
Year 2011 × Treat			0.025	[0.479]
Year 2012 × Treat			-0.024	[-0.446]
Year 2014 × Treat			-0.037	[-0.721]
Year 2015 × Treat			-0.082	[-1.614]
Year 2016 × Treat			-0.113*	[-2.238]
Year 2017 × Treat			-0.111*	[-2.207]
Year 2018 × Treat			-0.142**	[-2.857]
Year 2019 × Treat			-0.170**	[-3.404]
Observations	90,454		90,454	
R-squared	0.827		0.828	

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects.

Table A5 Treatment effects for Lima and other urban areas

Dependent: ln(Enrolment)	[1] Lima	[2] Other urban
Post × Treat	-0.058*	-0.115*
	[-2.432]	[-2.392]
Observations	52,552	38,032
R-squared	0.835	0.817

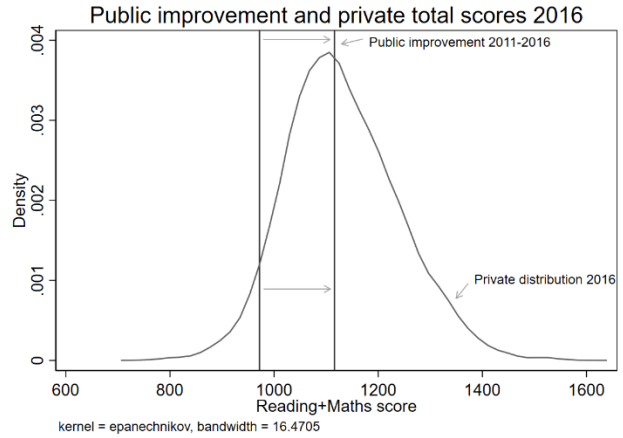
Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects and year effects. Lima is defined as departments of Lima and Callao.

APPENDIX C: Relative cost of public and private sector education in Peru in 2016

One way to gauge the cost-effectiveness of public education spending would be to compare the cost of educating a child in a private school versus a public school, *for a similar quality of the education.* Over the time period studied, Peru did not test primary school pupils in a way that would allow for value added of primary schooling to be estimated. However, grade 2 learning outcomes between private and public schools can be compared. This comparison is complicated by the fact that private sector pupils come from families with more resources. Further, to compare private and public costs of education, we have to include both urban and rural areas of the country since our budget data is at the level of regions, and we cannot separate expenditure in urban and rural areas.

Figure A1 shows the magnitude of the improvement in average public sector test scores, in comparison with the test score distribution for private schools in 2016 for Peru as a whole, including rural districts. Between 2011 and 2016, the public sector combined Reading and Mathematics scores increased from 971 to 1116, just about surpassing the modal private sector school scores in 2016.

Figure A1 Score distribution of private schools in 2016 (Reading + Maths) , and average public sector improvement from 2011 to 2016.



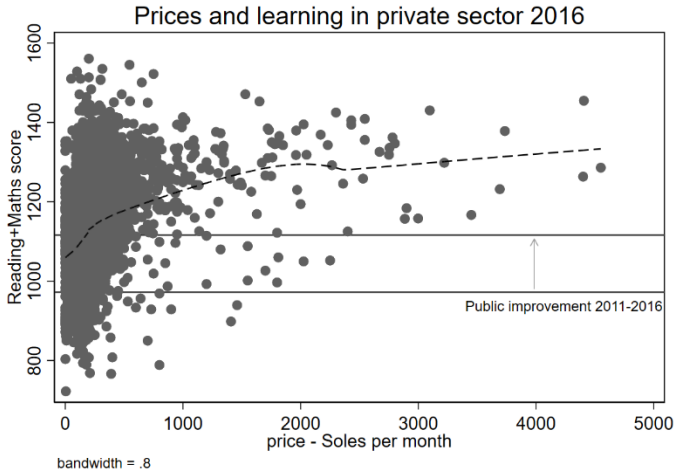
Notes: Data includes both urban and rural districts.

To compare public and private schools with a similar performance in 2016, we are interested in answering the question "How expensive would a private school need to be to achieve the same results as the public sector average?". In Figure A2, we plot private sector school fees (in

2020) and test results in 2016 on a scatterplot. The smoothed dashed line in the figure shows the local average score for each price level.

Private schools that charge fees of 140-240 soles per month produce on average the same results as the average public school. Assuming that the government could consistently and at scale 'purchase' schooling at the midpoint of this range (190 Soles) from the private sector**,** we can compute the private sector cost of producing the current average public outcomes. In 2016, there were about 2.56 million primary public pupils in Peru. Funding private education for all of these pupils annually at the price of 190 Soles per month, would cost 190*12*2.56 million = 5837 million Soles (US $1540 million).

Figure A2 Prices and learning in private sector schools in 2016.



Notes: Based on private schools in all of Peru in 2016. Dashed line is a smoothed local average of combined test score, based on the STATA command 'lowess'.

On the other hand, the total public sector education budget in 2016 for primary schooling was roughly 5960 million Soles.[6] Thus, based on this very simple calculation, the private sector would produce the education at about the same cost as the public sector for the same quality.

[6] From detailed 2016 budget items we added together 'Education primaria', 'Education basica especial' and ''Education basica alternativa'. Figures for Lima are from 'Gobierno national' and for the rest of the country from 'Gobiernos regionales', given that education for Lima is funded from the national budget, but for other regions, funding comes largely from the regional budget (Source: https://www.datosabiertos.gob.pe/dataset/ejecuci%C3%B3n-prepuestal-consulta-amigable-ministerio-de-econom%C3%ADa-y-finanzas-mef).

However, taking some important facts into consideration suggests that this conclusion may be premature.

The calculation is based on a number of simplifications. Firstly, since students in private sector schools come from wealthier backgrounds, it is quite possible that we underestimate the cost-effectiveness of the public sector as parental investments can feed into private sector results. Secondly, both public school results and the cost of private schooling differ dramatically by area. If the country is divided into three parts: Lima, urban districts outside Lima, and rural districts outside Lima, the monthly private school fees required to reach the local public sector mean performance in these areas would be 940 Soles, 300 Soles and 90 Soles, respectively. Applying these prices to public pupil populations in the respective regions, educating all existing public sector pupils privately would raise the cost to about 10.000 million Soles, nearly doubling the cost of private provision compared to the simplified estimate above. [7] Finally, the public sector cost of education may be undercounted due to existing school capital stock not being included in the cost, while private schools may need to cover rent of premises in their fees. Despite these numerous shortcuts, the public-sector cost effectiveness appears to be competitive in Peru in 2016.

[7] In 2016 there were 0.49 million public primary pupils in Lima, 0.86 million in urban districts outside Lima, and 1.34 million in rural districts outside Lima. The average public sector combined test scores were 1206 for Lima, 1176 for urban districts and 1089 for rural districts. The required total cost would be (0.49*940+0.86*300+1.34*90)*12 = 10070 million Soles per year.